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Which Came First, The Chicken or the Egg? What about Ducks?: Granger Causality Using Philippine Poultry Data

John Francis Diaz [a, *]

[a] *Department of Finance and Accounting, Asian Institute of Management, Makati, Philippines*

ABSTRACT

The paper studies Philippine poultry data and revisits the chicken or the egg causality problem to include ducks data. Using quarterly Philippine poultry production time-series from the first quarter of 1980 to the last quarter of 2014, this research finds that chickens came from eggs, which is consistent with the earlier statistical results of Thurman and Fisher (1988), and genetics-based conclusions of Eriksson et al. (2008). However, no conclusive evidence was found using the Philippine duck and duck eggs data. The chicken or the egg conundrum demonstrates the power of Granger causality testing in answering questions of temporal ordering that has various causal applications using macroeconomic, financial, and agricultural time-series data.

KEYWORDS

Granger Causality; Philippine Poultry Production; Chickens; Ducks and Eggs

* Corresponding author: John Francis Diaz
E-mail address: jdiaz@aim.edu

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1. Introduction

The chicken or the egg causality problem is actually a metaphorical question to represent the futility of determining the first case on a seemingly circular situation of cause and effect. However, the question of *"Which came first, the chicken or the egg?"* is a very intriguing question that one can't help but to take literally. Sciences, through the theory of evolution[1], have one of the best answers to this question. They concluded that an egg, which underwent mutation, produced the first chicken and possibly the first duck. A more recent scientific study of Freeman et al. (2010) suggested that chickens came first, because of the key chicken protein *"ovocleidin-17"* helps in the formation of the egg's hard shell.

Social Sciences also have a statistical answer through the seminal paper of Thurman and Fisher (1988), which demonstrated that the egg came first before the chicken, utilizing the Granger causality test (Granger, 1969)on the US chicken and egg annual production data from 1930 to 1983.Although, an econometric approach to an obvious genetics problem is unacceptable, the authors nevertheless established the applicability of the Granger causality test to answer a baffling and very interesting question. The statistical test has found its way to many time-series data applications. The recent study of Ajovin and Navarro (2015) applied Granger causality to examine the relationship of debt and economic growth of 16 OECD countries; Lee and Yang (2014) used it in the financial markets of the US, UK, and Japan; and both Nazioglu and Soytas (2012) and Sebri and Abid (2012) utilized the model in agricultural commodities prices.

The study is motivated by the fact that Granger causality test is a powerful tool to approach the "chicken and egg problem", and that there's an absence of previous studies tackling the question using other sets of data. The findings regarding Granger causality in the context of chicken and duck production have practical implications in various econometric applications. The study aims to validate the application of the Granger causality test in addressing complex questions, even those rooted in genetics. By using a different set of production data for chickens, eggs, and ducks, it contributes to the robustness of the Granger causality test as a tool in econometric analyses. Moreover, the research seeks to generalize the findings beyond the context of the initial study by Thurman and Fisher (1988). It aims to demonstrate that the Granger causality test is not limited to specific industries or regions but can be applied to diverse datasets, thereby enhancing its versatility and generalizability.

2. Data and Methodology

The paper examines quarterly data of chicken, ducks, and eggs production in thousands of metric tons from the first quarter of 1980 to the last quarter of 2014. The time-series containing 140 data points was sourced from the Philippines Statistics Authority (PSA) website under the livestock and poultry production section. A significant data limitation of this study is that the PSA's website did not separate which of the chickens and ducks are raised only for meat or for egg production; and which of those eggs are for fertilization or for food consumption. However, the data time-series is nevertheless still useful in fulfilling the major objectives of this study using the Granger causality test.

The idea of Granger causality is that if lagged or previous values of x (which can be chicken/duck and their eggs) help predict the current values of y (which can be chicken/duck or their eggs) in a predictive regression form, it is considered to be Granger-caused. The study implemented these notions by 1) regressing chickens or ducks

[1] Evolutionary theories suggest that species change over time through the slow process of mutation, which can take place at conception or within an egg such that a sexual reproduction of creatures similar to a chicken (i.e., proto-chickens) or a duck (i.e., proto-ducks), laid the first chicken and duck eggs. These hatched (mutated) eggs then turned into the modern version of chickens and ducks that inbred to produce the current species. It was believed that the modern chicken was a hybrid descendant of both closely-related bird species called the *red* and *grey junglefowls* according to Eriksson et al., (2008), while the domestic duck that we know today was also believed to have descended from related duck species called *mallards* or wild ducks (Rowe et al.,2004).

production (y variable) on lagged chickens or ducks (x_1), and lagged chicken eggs or duck eggs (x_2) productions, which take the following form:

$$chickens_t = \mu_t + \sum_{i=1}^{L} \alpha_i \, chickens_{t-i} + \sum_{i=1}^{L} \beta_i \, chicken \, eggs_{t-i} + \varepsilon_t \quad (1)$$

$$ducks_t = \mu_t + \sum_{i=1}^{L} \alpha_i \, ducks_{t-i} + \sum_{i=1}^{L} \beta_i \, duck \, eggs_{t-i} + \varepsilon_t \quad (2)$$

and by 2) regressing chicken eggs or duck eggs production (y variable) on lagged chicken eggs or duck eggs (x_1), and lagged chickens or ducks (x_2) productions, which can be specified as:

$$chicken \, eggs_t = \mu_t + \sum_{i=1}^{L} \alpha_i \, chicken \, eggs_{t-i} + \sum_{i=1}^{L} \beta_i \, chickens_{t-i} + \varepsilon_t \quad (3)$$

$$duck \, eggs_t = \mu_t + \sum_{i=1}^{L} \alpha_i \, duck \, eggs_{t-i} + \sum_{i=1}^{L} \beta_i \, ducks_{t-i} + \varepsilon_t \quad (4)$$

To conclude that one of the two variables (i.e., chicken/duck and their eggs) came first, the study should find a uni-directional causality from one variable to the other variable (e.g., chicken/duck to eggs or eggs to chicken/duck); and find no causation from the other variable.

3. Empirical Results

The Granger causality analysis was conducted with one to three lags for chickens, ducks, and their eggs. In Table 1a., it is evident that both the lagged values of chicken and eggs significantly influence current chicken production, holding true for all three lags. Notably, the first lag exhibits the highest R-squared (0.858) and the lowest AIC (10.198), suggesting it is the most robust model among the three simulations. Consequently, the study concludes that chicken eggs precede chickens. This outcome aligns with the initial findings of Thurman and Fisher (1988) and corresponds with the historical scientific explanations of Eriksson et al. (2008).

Table 1a. Did the chicken egg come first?

Variable	Coefficient	Probability	R-squared	AIC
Constant	-4.735	0.589		
Chicken (-1)	0.267***	0.002	0.858	10.198
Chicken Eggs (-1)	2.823***	0.000		
Constant	-6.001	0.506		
Chicken (-2)	0.325***	0.003	0.850	10.246
Chicken Eggs (-2)	5.064***	0.000		
Constant	2.817	0.767		
Chicken (-3)	0.354***	0.000	0.835	10.337
Chicken Eggs (-3)	2.449***	0.000		

*Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.*

However, this pattern does not hold for ducks. As depicted in Table 1b., from lags one to three, previous values

of ducks consistently determine current duck production. The coefficient for duck egg production determining current duck values is only significant at lag two, but this model exhibits the lowest R-squared (0.296) and the highest AIC (4.454). This inconclusive outcome suggests that the econometric idea of duck eggs causing ducks lacks robust support.

Table 1b. Did the duck egg come first?

Variable	Coefficient	Probability	R-squared	AIC
Constant	3.044***	0.000		
Duck (-1)	0.696***	0.000	0.502	4.100
Duck Eggs (-1)	0.026	0.691		
Constant	4.231***	0.000		
Duck (-2)	0.398***	0.000	0.296	4.454
Duck Eggs (-2)	0.225***	0.005		
Constant	3.251***	0.000		
Duck (-3)	0.647***	0.000	0.441	4.232
Duck Eggs (-3)	0.054	0.444		

*Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.*

Table 2 summarizes the determinants of chicken and duck eggs production. Table 2a. indicates that from lags one to three, previous values of chicken egg production consistently determined current values of chicken egg production. However, the lagged chicken production coefficient is only significant at lag three, but this model has the lowest R-squared (0.966) and the highest AIC (5.916). The study surmised that that the idea of chickens determining eggs is inconclusive.

Table 2a. Did the chicken come first?

Variable	Coefficient	Probability	R-squared	AIC
Constant	0.853	0.345		
Chicken Eggs (-1)	1.017***	0.000	0.974	5.650
Chicken (-1)	-0.006	0.511		
Constant	1.096	0.213		
Chicken Eggs (-2)	0.988***	0.000	0.976	5.584
Chicken (-2)	0.003	0.723		
Constant	1.815*	0.083		
Chicken Eggs (-3)	0.908***	0.000	0.966	5.916
Chicken (-3)	0.024**	0.018		

*Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.*

For the duck egg production, Table 2b. also shows that from lags one to three, previous values of duck egg production consistently determined current values of duck egg production. However, no significant values of lagged duck production were observed, which means that ducks do not precede their eggs.

Table 2b. Did the duck come first?

Variable	Coefficient	Probability	R-squared	AIC
Constant	2.525***	0.001		
Duck Eggs (-1)	0.682***	0.000	0.523	4.116
Duck (-1)	0.072	0.298		
Constant	0.723*	0.076		
Duck Eggs (-2)	0.907***	0.000	0.866	2.843
Duck (-2)	0.026	0.473		
Constant	2.938***	0.000		
Duck Eggs (-3)	0.636***	0.000	0.478	4.194

Duck (-3)	0.081	0.269

*Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.*

The study's findings contribute to the ongoing refinement of econometric models, especially those involving time-series data. Researchers and econometricians can use the results to further develop and improve models that explore causality relationships in complex systems, extending beyond poultry farming to other economic sectors. Agribusinesses can incorporate the causal relationships identified in the study into predictive modeling efforts. By considering the lead-lag dynamics between chicken, duck, and egg production, businesses can enhance their forecasting accuracy, which is crucial for effective resource planning, marketing strategies, and meeting consumer demand.

4. Conclusions and Recommendations

The econometric findings of this research conclude that Philippine chicken eggs precede chickens, which is consistent with the statistical findings of Thurman and Fisher (1988), and also coincide with the scientific conclusions of Eriksson et al. (2008) that chickens indeed came from eggs. However, no conclusive results were found using Philippine duck and duck eggs data. This study suggests that future econometric inquiries on the subject should use (if possible) only production data of chickens capable of producing eggs and not to include those from commercial broilers, in the same way eggs data should be only those that are potentially fertilizable.

These data limitations pose a great challenge on the accuracy of statistically answering the question *"Which came first, the chicken or the egg?".* Given these shortcomings, econometric approaches in answering this metaphorical question should be taken on the basis of answering the question of temporal ordering. The study may explore potential adaptations or improvements to the Granger causality test methodology based on the analysis of chicken, egg, and duck production data. This could lead to refinements in econometric techniques, making them more applicable to various research questions. Further studies are suggested to also explore the various applications of causality testing using macroeconomic, financial, and agricultural time-series data further.

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Conflict of interest

The author claims that the manuscript is completely original. The author also declares no conflict of interest.

Author contributions

The author was solely responsible for all aspects of the research, including conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing – original draft, and writing – review & editing.

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